Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 6, No. 6, p. 76-82, 2015
http://www.innspub.net

INNSPUB
RESEARCH PAPER
OPEN ACCESS

Evaluation of plant diversity in pure and mixed Plantations of *Cupressus arizonica* – Iran

E. Amirahmadi[1*], M.R. poormajidian[2], S.M. Hojjati[2], A. najjari[3]

[1]*MSc. Student, Faculty of Natural Resources, Sari Agricultural Sciences and Natural Resources University, Iran*

[2]*Associate Professor, Faculty of Natural Resources, Sari Agricultural Sciences and Natural Resources University, Iran*

[3]*M.Sc. in Forestry. The Deputy of Natural Resources and Watershed Alborz Province, I. R. Iran*

Article published on June 04, 2015

Key words: Biodiversity, Pure and mixed Plantations, Iran.

Abstract

The present study was conducted to investigate the effect of tree mixture on plant biodiversity in *Cupressus arizonica* plantations. Plantations are primarily established in order to achieve economic objectives, such as the profitable income derived from the timber production and from other wood products. today, attention to the other services. These services include biodiversity maintenance and natural regeneration. Biodiversity has been shown to play a key role at all levels of the ecosystem service hierarchy. Up to now, few studies about the effects of biodiversity on ecosystem functioning have been done in the mixed and pure plantation and the influence of biodiversity on stability and ecosystem functioning remains less clear. Therefore, in this study, plant biodiversity evaluated in mixed and pure stands to be determined mixture what type of effect on plant biodiversity. The study site was Khargosh Valley Forest Park, located In the vicinity of the metropolis of Tehran province in the Iran country. To analyze the data, the average percentage of coverage gramineous and in this study, the biodiversity, richness and evenness were calculated. The results of this study showed that the abundance and diversity of gramineous species in the understory of mixed plantations of *Cupressus arizonica* with deciduous hardwood tree were greater than other stands. According to the results obtained from this research, recommended for the establishment of conifer plantation, used mixed cultures of conifers with broadleaf instead of pure cultures conifers.

***Corresponding Author:** E. Amirahmadi ✉ amirahmadielnaz@gmail.com

Introduction

Plantations currently cover approximately 187 million ha worldwide and are being established at an annual rate of 4.5 million ha (Stephens and Wagner, 2007; Bremer and Farley, 2010; Chen *et al.,* 2014). Plantations are primarily established in order to achieve economic objectives, such as the profitable income derived from the timber production and from other wood products (Chen *et al.,* 2014), But today, the purpose of plantation not only timber production, attention to the other services. These services include biodiversity maintenance and natural regeneration (Aubin *et al.,* 2008; Duan *et al.,* 2009; Bremer and Farley, 2010).

Biodiversity has been shown to play a key role at all levels of the ecosystem service hierarchy (Mace *et al.,* 2012; Gao *et al.,* 2014). However, these biologically diverse systems are increasingly being threatened by deforestation and forest degradation via varied direct or indirect mechanisms (Dirzo and Raven, 2003). Therefore, conserving forest biodiversity has become a critical task at local, national and global level (Gao *et al.,* 2014).

Effects of biodiversity on ecosystem functioning have emerged as one of central issues in ecological and environmental sciences (Wensheng *et al.,* 2014). A step further in biodiversity assessment needs to consider the role of each species in ecosystems or species responses to environmental conditions, which is actually what the functional view of biotic communities aims to quantify (McGill *et al.,* 2006). Some studies demonstrated that effects of biodiversity on ecosystem functioning mainly attributed to functional traits of species and species interactions (such as direct or indirect competition, facilitation) rather than species richness (Díaz *et al.,* 2007; Quétier *et al.,* 2007).

Biodiversity loss is a major threat to ecosystems and to the well-being of mankind (Berenice Diaz-Rodriguez *et al.,* 2012). When mismanaged, ecosystems degrade with the consequent loss of biodiversity and ecosystem services (Bennet and Balvanera, 2007). Biological diversity has become an issue of pressing concern as we are evidently undergoing one of the worst biological crises in Earth history (Berenice Diaz-Rodriguez *et al.,* 2012).

Concerns about an accelerated loss of species diversity have stimulated an increasing interest in the potential impact of biodiversity on ecosystem processes (Hooper *et al.,* 2005; Christiane Roscher *et al.,* 2013). Understanding the mechanisms that control community level phenomena of assembly, compositional stability and resistance against invasion is essential to assess consequences of species loss (Christiane Roscher *et al.,* 2013).

Many studies have shown that given the correct conditions, mixed-species forests and plantations can be more productive than monospecific stands (Kelty, 1992, 2006; Forrester *et al.,* 2006; Forrester, 2014). Mixed-species stands are viewed as one of the most important adaptation and risk reduction strategies (Reif *et al.,* 2010). The practice of planting monospecific can lead to a decline in litter quality and soil fertility and to frequent pest outbreaks and can alter the soil food site (Xiaoli *et al.,* 2015). The dense canopies and low light availabilities of pure plantations lead to low levels of understory species richness and biomass compared with mixed plantations (Xiaoli *et al.,* 2015).

Microclimatic conditions in which decomposition take place (like temperature, moisture within a forest floor and light distribution) which dependent on tree canopy. Biomass, diversity and activity of decomposing organisms, As described by Wilkinson and Anderson (2001) and Prescott (2002) all of those factors are related directly and indirectly to the forest canopy (Hojjati, 2008). Species composition can alter ecosystem properties through functional traits and interactions (Marcus Schmidt *et al.,* 2015). Evidence is growing that mixed-species forest stands can supply many ecological, economical and socio-cultural forests goods and services in a similar or even better way as far-from-nature monocultures (Gamfeldt *et al.,* 2013). Plant biodiversity data are needed to make conservation and management decisions and recommendations (Mack *et al.,* 2007; Symstad and Jonas, 2011; Hooper *et al.,* 2012; D. Toledo *et al.,* 2014).

in this study, plant biodiversity evaluated in mixed and pure stands to be determined mixture what type of effect on plant biodiversity.

Material and methods

Study areas: The study site was Khargosh Valley Forest Park, located In the vicinity of the metropolis of Tehran province in the Iran country, with an area of 67 hectares (Fig. 1). Which established in the years 1961-1971 with the purpose of tourism and creation of green spaces. Its geographical location within 51˚ 15 ´29" to 51˚ 15´ 49" East longitude and north latitude is 35˚ 43´ 04" to 35˚ 43´ 27" .

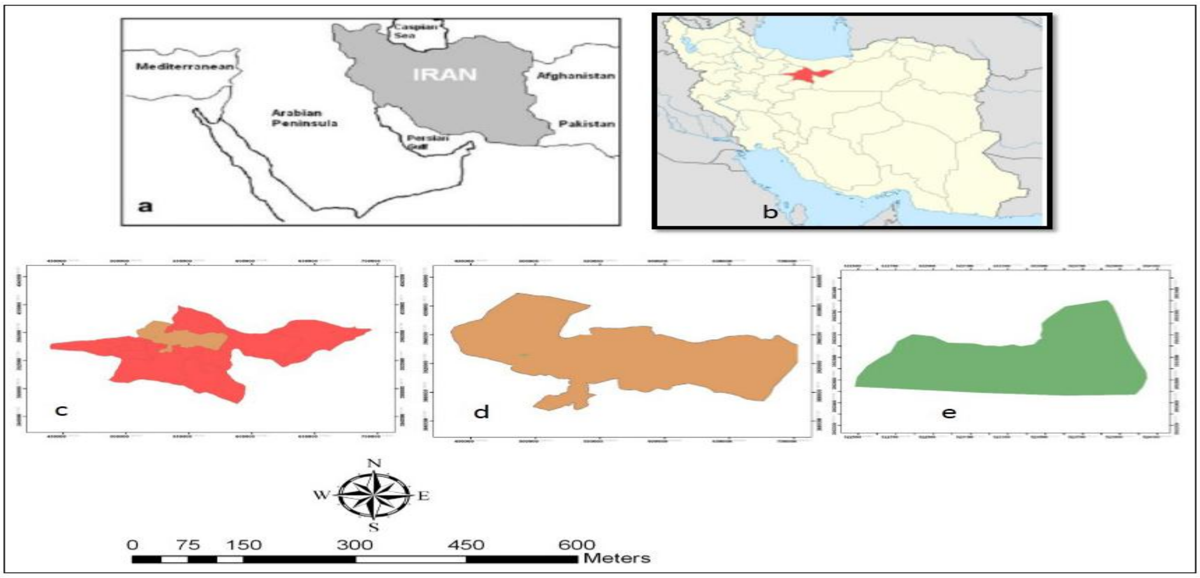

Fig. 1. Location map for observational study site: (a and b) Iran Country. (c) Tehran Province. (d) Tehran city. (e) Khargosh Valley Forest Park.

Climatic factors: In this regard, was used the data of the synoptic station Tehran Mehrabad nearest station to khargosh Valley Forest Park project. In connection with rainfalls, According to statistics for a period of 24 years from 1980 until 2003, was observed that the highest rainfall in the autumn and winter and beginning of spring, These times coincides with the slow growth of plants or their physiologically. According to information obtained in a 24 year period from 1980 to 2003, The average rainfall over a period of 24 years were 240.3 mm, that In total amount is not sufficient And When the distribution is highly inappropriate. On the other hand, the long dry period is also negative impact on the biological activity of plants. By analyzing the statistical data, was found the highest amount of rainfall in the winter was 110.06 mm and the lowest rainfall in summer with 4 mm.

Temperature: According to the results, Monthly and annual temperature region during the years 1980-2003 in a period of 24 years: Annual average of at least 11.4 ° C and Average annual maximum was 24.2 ° C.

Sampling and data collection: Sampling method was done With a Systematic random network with dimensions 75 × 75 and the confluence of the sides of the network were considered as the center of the plot. Samples parts were Square with dimensions of 20 × 20 m, then in each plot was recorded existing trees with respect to the tree species and number of species. To calculate the gramineous cover, in each plot was implemented 5 micro-plots with dimensions of 1 × 1 m In four directions, north, south, east, west and center, then gramineous cover were recorded In percent for each micro plots.

Data analysis: To analyze the data, the average percentage of coverage gramineous and in this study, the biodiversity, richness and evenness were calculated. To calculate the variation was used to the index of Shannon-Wiener and Simpson, to account for the richness was used to the Margalef and Menhinic index and to account for the evenness was used to the Berger Parker and evenness index. Statistical analysis was performed in Past software (ver.2.15). After the calculation of diversity, evenness and richness, their statistical characteristics (Standard deviation, standard error, confidence and percent error) was calculated to the statistical software SPSS 20. To investigate the difference between the values of diversity, evenness and richness was used of the One Way ANOVA in four stands.

In total, this study included 4 different type of stands, 1- The Standing pure *Cupressus arizonica* (Number of plots = 21), 2- the standing pure *Pinus eldarica* (Number of plots =28), 3- the standing mixed *Cupressus arizonica* and *Pinus eldarica* (Number of plots =8) and 4- the standing mixed *Cupressus arizonica* with Deciduous hardwoods (Number of plots =12).

Results

Number of Gramineous species in pure stands of *Cupressus arizonica* are 8 types, in pure stands of *Pinus eldarica* are 2 types, in the standing mixed *Cupressus arizonica* and *Pinus eldarica* are 6 types and in the standing mixed *Cupressus arizonica* with deciduous hardwoods are 14 types (appendix A).

Table 1. Average of Gramineous cover diversity index (± standard error) in the studied stands.

Type of stand/ Diversity index	pure *Cupressus arizonica*	pure *Pinus eldarica*	mixed *Cupressus arizonica* and *Pinus eldarica*	mixed *Cupressus arizonica* with Deciduous hardwoods
Simpson	0.081±0.04^{c}	0.035±0.01^{c}	0.511±0.02^{b}	0.778±0.02^{a}
Shannon	0.162±0.10^{c}	0.058±0.02^{c}	0.882±0.03^{b}	1.656±0.00.9^{a}
Margalef	0.173±0.11^{c}	0.644±0.03^{c}	0.860±0.09^{b}	1.637±0.16^{a}
Menhinick	0.476±0.08^{ns}	1.352±0.8^{ns}	0.880±0.11^{ns}	1.241±0.11^{ns}
evennes	0.981±0.01^{a}	0.962±0.01^{a}	0.780±0.02^{c}	0.874±0.01^{b}
Berger–Parker	0.933±0.04^{a}	0.978±0.01^{a}	0.640±0.02^{b}	0.302±0.02^{c}

Diversity index	Source variations	Sum of Squares	Mean Square	F	Sig
Simpson	Between Groups	5.756	1.919	87.172	0.000
	Within Groups	1.431	0.022		
	Total	7.187			
Shannon	Between Groups	24.908	8.303	81.703	0.000
	Within Groups	6.605	0.102		
	Total	31.513			
Margalef	Between Groups	23.967	7.989	48.609	0.000
	Within Groups	10.683	0.164		
	Total	34.650			
Menhinick	Between Groups	10.211	3.404	0.475	0.700
	Within Groups	465.293	7.158		
	Total	475.504			
evennes	Between Groups	0.302	0.101	15.936	0.000
	Within Groups	0.411	0.006		
	Total	0.712			
Berger–Parker	Between Groups	4.417	1.472	92.637	0.000
	Within Groups	1.033	0.016		
	Total	4.450			

Results of Diversity: Check Indicators of biodiversity in Four stands showed that Shannon-Wiener and Simpson Diversity index was highest value in the standing mixed *Cupressus arizonica* with Deciduous hardwoods, These indicators in the standing mixed *Cupressus arizonica* and *Pinus eldarica* was intermediate level and in pure stands of *Cupressus arizonica* and pure stands of *Pinus eldarica* were the lowest level.

Results of richness: Results showed Menhinic indices did not show significant differences between the four stands but the Margalef index shows a significant difference between the four stands, Thus which is: Margalef index was highest value in the standing mixed *Cupressus arizonica* with Deciduous hardwoods, These indicators in the standing mixed *Cupressus arizonica* and *Pinus eldarica* was intermediate level and in pure stands of *Cupressus arizonica* and pure stands of *Pinus eldarica* were the lowest level.

Results of evenness: Results showed Berger Parker and evenness index were highest value in pure stands of *Cupressus arizonica* and pure stands of *Pinus eldarica*. The Berger Parker index in the standing mixed *Cupressus arizonica* and *Pinus eldarica* was highest than the standing mixed *Cupressus arizonica* with Deciduous hardwoods. The evenness index in the standing mixed *Cupressus arizonica* with Deciduous hardwoods was highest than the standing mixed *Cupressus arizonica* and *Pinus eldarica*.

Discussion

The results of several studies indicate that plantations have good potential to accelerate processes that are conducive to restoring and enhancing biodiversity (uariguata *et al.,* 1995; Powers *et al.*, 1997; Lugo, 1997; Parrotta, 1999; Carnevale and Montagnini, 2002; Yirdaw and Luukkanen, 2003). Species diversity is important for ecosystem function. The conservation of species diversity is the most important long-term goal essential for maintaining ecosystem function.

Plantation in arid areas takes place mainly with species of conifers, because conifers are resistant, but It is generally considered that conifers are less favorable to understory diversity than deciduous trees. By increasing resource diversity, mixed stands have been assumed to host a more heterogeneous and species-rich flora than pure stands (Barbier *et al.*, 2008).

In the other hand, Monocultures stands, to be more sensitive to natural and anthropogenic forms of stress such as storm events, insect attacks, droughts and other impacts of climate change. Mixed forest types are currently recommended by foresters in order to improve the stability and biodiversity value of forest ecosystems (Hooper *et al.*, 2005; Hojjati 2008).

Conclusion

The results of this study showed that the abundance and diversity of gramineous species in the understory of mixed plantations of *Cupressus arizonica* with deciduous hardwoods tree was greater than other stands.

The mixed stands are multistoried, in these stands will absorb more light from storey spaces, This makes faster decomposition of litter and needles the floor, Therefore, the conditions provided for regeneration and growth of floor species. The mixing of litters may promote decomposition and in turn nutrient availability. Resources with dissimilar availability in different litters can be shared when litters are mixed, e.g. the decomposition of a slowly decomposing litter can be enhanced by the addition of a faster decomposing litter. The addition of understory litter in mixed-species stands may further promote the litter quality. The understory is usually poorly developed in monoculture stands. Higher quality litter provides a more suitable environment for soil fauna, e.g. earthworms, which in turn speeds up decomposition and mineralization (Thelin *et al.*, 2002).

Acknowledgements

We have very appreciated Of Mr. Mahya Tafazzoli, PhD Student, Faculty of Forest Sciences, Sari University of Agricultural Sciences and Natural Resources, I. R. Iran, for aid in the statistical analysis of this study.

References

Aubin I, Messier C, Bouchard A. 2008. Can plantations develop understory biological and physical attributes of naturally regenerated forests? Biodivers Conserv **8,** 2461–2476.

Barbier S, Gosselin F, Balandier P. 2008. Influence of tree species on understory vegetation diversity and mechanisms involved—a critical review for temperate and boreal forests. Forest ecology and management **254(1),** 1-15.

Bremer LL, Farley KA. 2010. Does plantation forestry restore biodiversity or create green deserts? A synthesis of the effects of land-use transitions on plant species richness. Biodivers Conserv **19,** 3893–3915.

Carneval NJ, Montagnini F. 2002. Facilitating regeneration of secondary forests with the use of mixed and pure plantations of indigenous tree species. Forest Ecology and Management **163**, 217-227.

Chen Y, Cao Y. 2014. Response of tree regeneration and understory plant species diversity to stand density in mature Pinus tabulaeformis plantations in the hilly area of the Loess Plateau, China. Ecological Engineering **73,** 238-245.

Dirzo R, Raven PH. 2003. Global state of biodiversity and loss. Annual Review of Environment and Resources **28,** 137–167.

Duan RY, Wang C, Wang XA, Zhu ZH, Guo H. 2009. Differences in plant species diversity between conifer (Pinus tabulaeformis) plantations and natural forests in middle of the Loess Plateau Russ. Russian journal of ecology **40,** 501–509.

Forrester DI. 2014. The spatial and temporal dynamics of species interactions in mixed-species forests: from pattern to process. Forest Ecology and Management **312,** 282-292.

Forrester DI, Bauhus J, Cowie AL, Vanclay JK. 2006. Mixed-species plantations of Eucalyptus with nitrogen fixing trees: a review. Forest Ecology and Management **233,** 211–230.

Gamfeldt L, Snäll T, Bagchi R, Jonsson M, Gustafsson L, Kjellander P, Ruiz-Jaen MC, Fröberg M, Stendahl J, Philipson CD, Mikusinski G, Andersson E, Westerlund B, Andrén H, Moberg F, Moen J, Bengtsson J. 2013. Higher levels of multiple ecosystem services are found in forests with more tree species. Nature communications **4,** 1340.

Gao T, Hedblom M, Emilsson T, Nielsen AB. 2014. The role of forest stand structure as biodiversity indicator. Forest Ecology and Management **330,** 82-93.

Guariguata M, Rheingans R, Montagnini F. 1995. Early woody invasion under tree plantations in Costa Rica: implications for forest restoration. Restoration Ecology **3,** 252- 260.

Hojjati SM. 2008. The impact of canopy composition on the nutritional status of an admixed spruce and beech forest at Solling, central Germany. na.

Hooper DU, Chapin FS, Ewel JJ, Hector A, Inchausti P, Lavorel S, Lawton JH, Lodge DM, Loreau M, Naeem S, Schmid H, Symstad AJ, Vandermeer J, Wardle DA. 2005. Effects of biodiversity on ecosystem functioning: a consensus of current knowledge. Ecological monographs **75,** 3-35.

Kelty MJ. 1992. Comparative productivity of monocultures and mixed-species stands. In: Kelty, M.J., Larson, B.C., Oliver, C.D. (Eds.), The Ecology and Silviculture of Mixed-Species Forests. Kluwer Academic Publishers, Dordrecht, 125–141 p.

Kelty MJ. 2006. The role of mixtures in plantation forestry. Forest Ecology and Management **233**, 195–204.

Lugo AE. 1997. The apparent paradox of reestablishing species richness on degraded lands with tree monocultures. Forest Ecology and Management **99,** 9-19.

Mace GM, Norris K, Fitter AH. 2012. Biodiversity and ecosystem services: a multilayered relationship. Trends in ecology and evolution **27,** 19–26.

Parrotta JA. 1999. Productivity, nutrient cycling, and succession in single- and mixedspecies plantations of Casuarina equisetifolia, Eucalyptus robusta and Leucaena leucocephala in Puerto Rico. Forest Ecology and Management **124,** 45-77.

Powers JS, Haggar JP, Fisher RF. 1997. The effect of overstory composition on understory woody regeneration and species richness in seven year old plantation in Costa Rica. Forest Ecology and Management **99,** 43- 54.

Stephens SS, Wagner MR. 2007. Forest plantations and biodiversity, a fresh perspective Forest **7,** 307–313.

Thelin G, Rosengren U, Callesen I, Ingerslev M. 2002. The nutrient status of Norway spruce in pure and in mixed-species stands. Forest Ecology and Management **160(1),** 115-125.

Yirdaw E, Luukkanen O. 2003. Indigenous woody species diversity in Eucalyptus globules plantations in the Ethiopian highlands. Biodiversity and Conservation **12,** 567- 582.

Appendix A. Presence or absence of Gramineous species in the studied stands.

Type of stands/ species	pure *Cupressus arizonica*	pure *Pinus eldarica*	mixed *Cupressus arizonica* and *Pinus eldarica*	mixed *Cupressus arizonica* with Deciduous hardwoods
Acanthophyllum microcephalum	+	+	+	+
Agropyron cristatum	+	-	-	+
Agropyron desertorum	-	-	-	+
Agropyron pectinoforme	-	-	-	+
Agropyron podperae	+	-	-	+
Alopecurus arundinaceus	+	-	-	+
Arrhenatherum elatius	+	-	+	+
Artemisia herba-alba	-	-	+	+
Capsella bursa-pastoris	+	-	+	+
Cousinia stocksi	+	-	+	+
Dactylis glomerata	-	-	-	+
Poa bulbosa	-	-	-	+
Sisymbrium Irio	-	-	-	+
Ephedra procera	+	+	+	+